# SASP

# Science Additional Specialism Programme

## Diagnostic tool – Physics

This diagnostic tool is designed to help you and your course tutor(s) assess your knowledge and understanding of physics at the start of the course, identifying areas of strength and areas for development.

Feedback will be available, broken down into the main areas of physics.

For this paper you will need:

- an answer sheet, or a spreadsheet on which to record your answers

**There are 30 questions.**

**It should take no more than 45 minutes to complete all questions.**

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Instructions:

- Each question is multiple choice, with three to five options.
- Choose only one answer for each question.
- Record your answers on the answer sheet or spreadsheet provided.
- Do all rough work on this question book.
- Make sure that you hand in the question paper when you have finished.

For each question, please also indicate the confidence you have in your answer, on a scale where

**1** = just guessing

**2** = not confident

**3** = fairly confident

**4** = very confident

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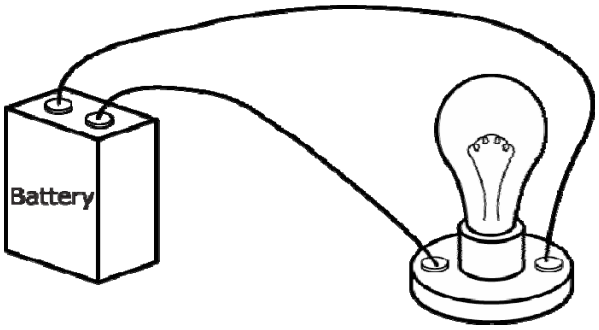
IOP Institute of Physics

**1.**

In this circuit, the bulb is lit.




**(a)** Read these two statements and decide if each is true or false.

**Statement 1:** There are free electric charges present in the battery and the wires all the time. Connecting the battery makes these charges all move together round the circuit.

**Statement 2:** There are no free charges in the wire until the battery is connected. Chemical reactions in the battery make electric charge. When the circuit is connected up, these charges flow out of the battery into the wire and on round the circuit.

Which row of this table (A, B, C or D) correctly shows if each statement is true or false?

| | **Statement 1** | **Statement 2** |
|---|---|---|
| **A** | True | True |
| **B** | True | False |
| **C** | False | True |
| **D** | False | False |

**(b)** Read these two statements about **what is happening in the bulb** and decide if each is true or false.

**Statement 1:** Collisions between the moving electric charges and the fixed atoms in the filament makes it heat up and glow.

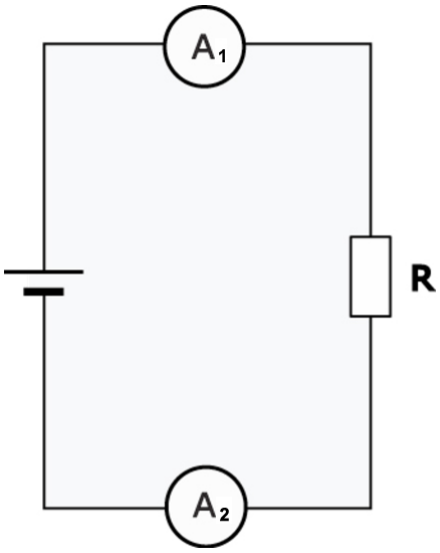
**Statement 2:** The electric charges are used up in the bulb, to produce light.

Which row of this table (A, B, C or D) correctly shows if each statement is true or false?

| | **Statement 1** | **Statement 2** |
|---|---|---|
| **A** | True | True |
| **B** | True | False |
| **C** | False | True |
| **D** | False | False |

**2.**

In this circuit, a battery is connected to a resistor, **R**.
There is a reading on both ammeters.




**(a)** What can you say about the readings on the two ammeters?

**A** The reading on ammeter A1 is bigger.

**B** The reading on ammeter A2 is bigger.

**C** The readings on the two ammeters are the same.

**(b)** How would you explain this?

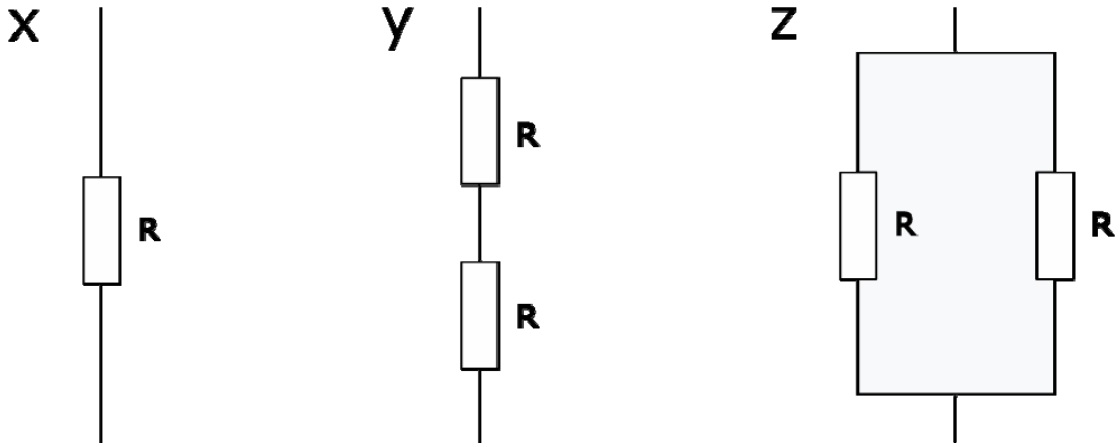
**A** The current is the same all round the circuit.

**B** Some of the current is used up by the resistor.

**C** All of the current is used up by the resistor.

**3.**

All of the resistors **R** shown below are identical.




Put these resistor combinations, X, Y, Z in order, from the one with the smallest total resistance, to the one with the largest total resistance.

**A** X has the smallest resistance, then Z, and Y is the biggest

**B** X has the smallest resistance; Y and Z are equal and bigger

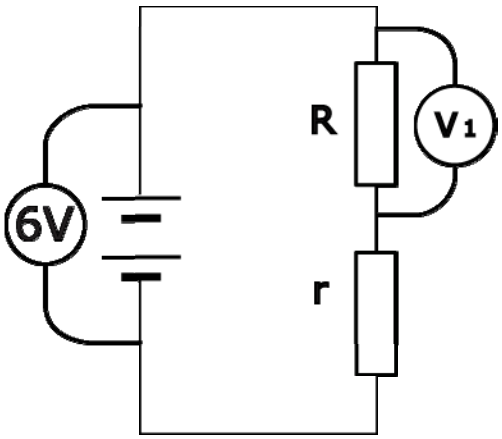
**C** X has the smallest resistance, then Y, and Z is the biggest

**D** Z has the smallest resistance, then X, and Y is the biggest

**E** Z has the smallest resistance, then Y, and X is the biggest

**4.**

In this circuit, the resistor R has a large resistance and the resistor r has a small resistance.




What will be the reading on the voltmeter?

**A** Exactly 6 V

**B** Slightly less than 6 V

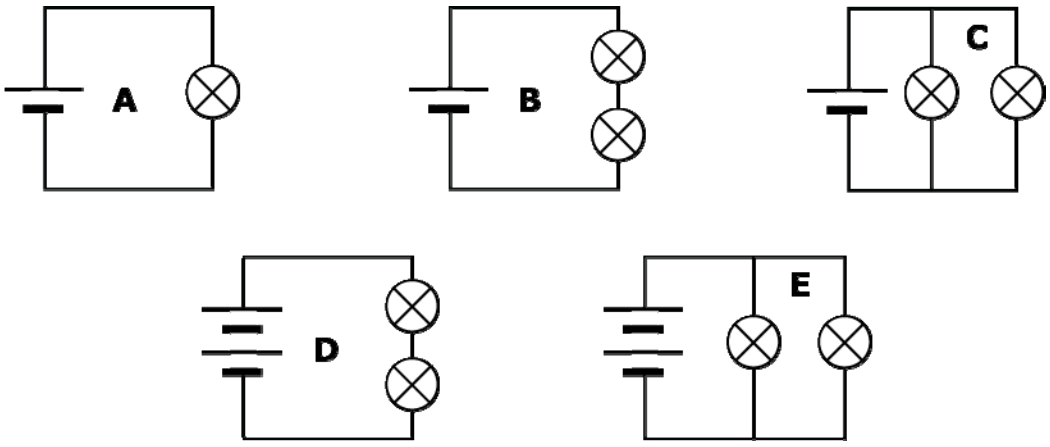
**C** Exactly 3 V

**D** Slightly above 0 V

**E** Exactly 0 V

**5.**

These five circuits contain similar lamps and cells.




**(a)** In which circuit will you see the brightest lamp?

**(b)** In which circuit will the cell(s) last longest?

**6.**

Anita and Julia have made a simple magnet with an iron core and wire; they are now trying to make it stronger. They tried these changes:

**Change 1:** Using more turns of wire

**Change 2:** Using a thinner iron core

**Change 3:** Increasing the electric current

**Change 4:** Using an aluminium core

Which of these would work?

**A** 1 only

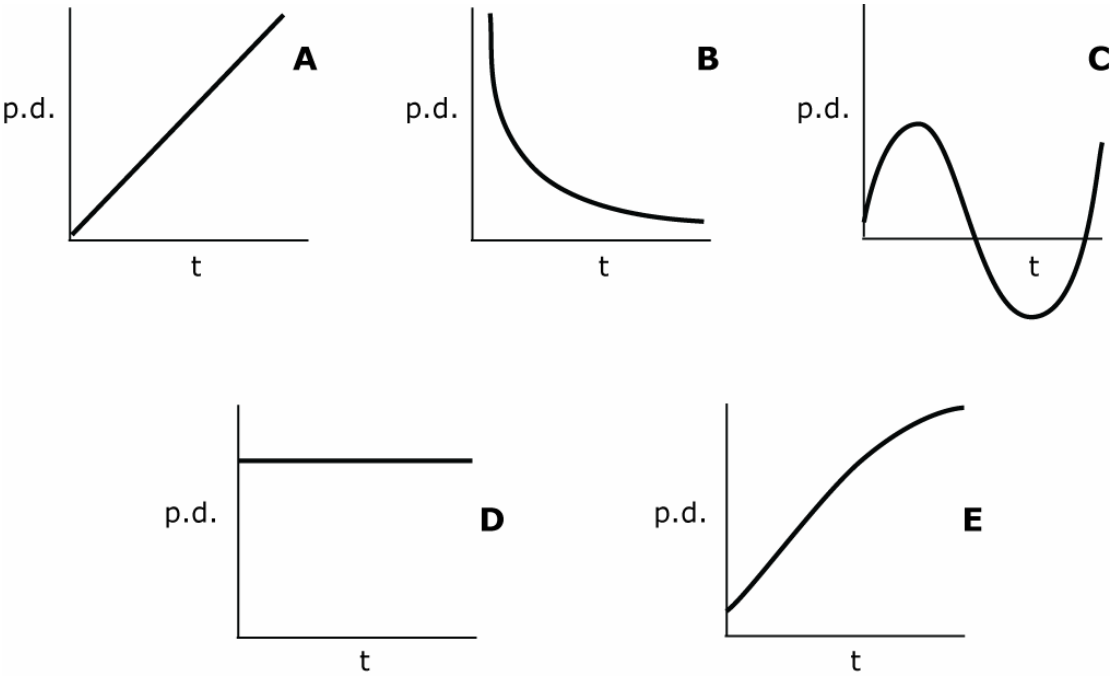
**B** 2 only

**C** 1 and 3 only

**D** 2 and 3 only

**7.**

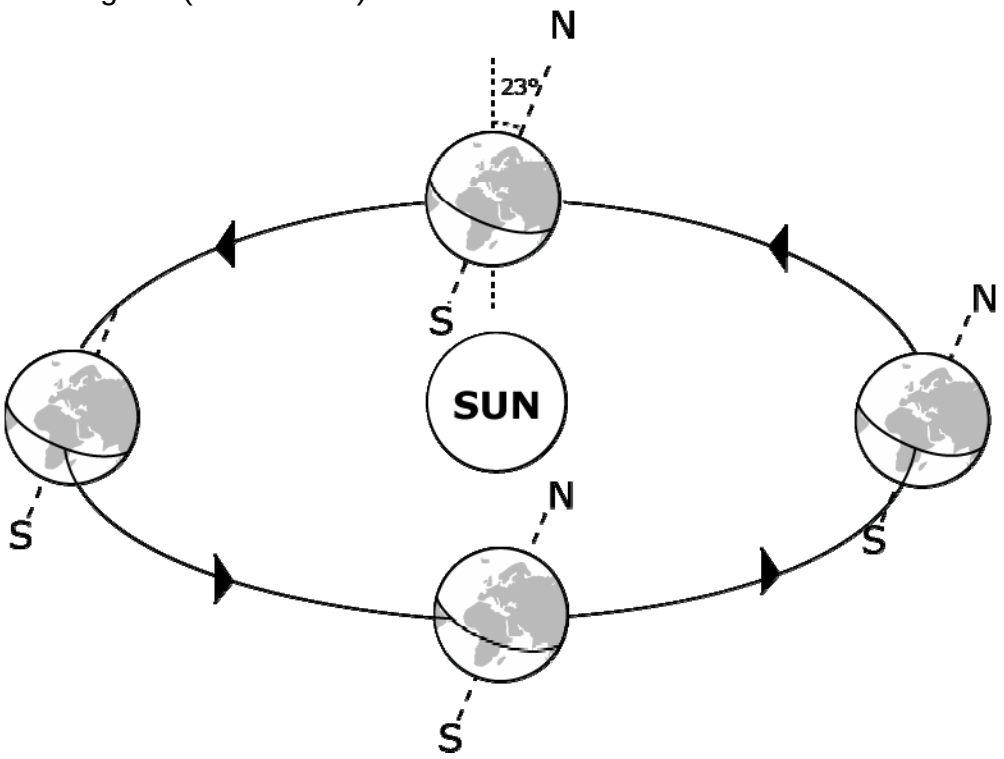
Look at these graphs:




A dynamo (generator) is turning at a steady rate. Which graph best represents its output, with potential difference plotted against time?

**8.**

The Earth moves around the Sun with its rotation axis tilted at 23° as shown in the diagram (not to scale).




Suppose that the Earth's axis was made to tilt at 35°, without changing anything else. What effect would this have?

**(a)** The length of the day from midnight to midnight would be

**A** Longer than 24 hours

**B** Shorter than 24 hours

**C** 24 hours

**(b)** The UK would get

**A** Longer periods of daylight in summer and shorter in winter

**B** Shorter periods of daylight in summer and longer in winter

**C** The same length of day and night that we get now

**9.**

An astronaut is standing still on the Moon's surface. Which one of these statements is true?

**A** There's no gravity but he wears heavy boots to keep him stuck to the ground.

**B** There is gravity on the Moon but it is not as strong as on Earth.

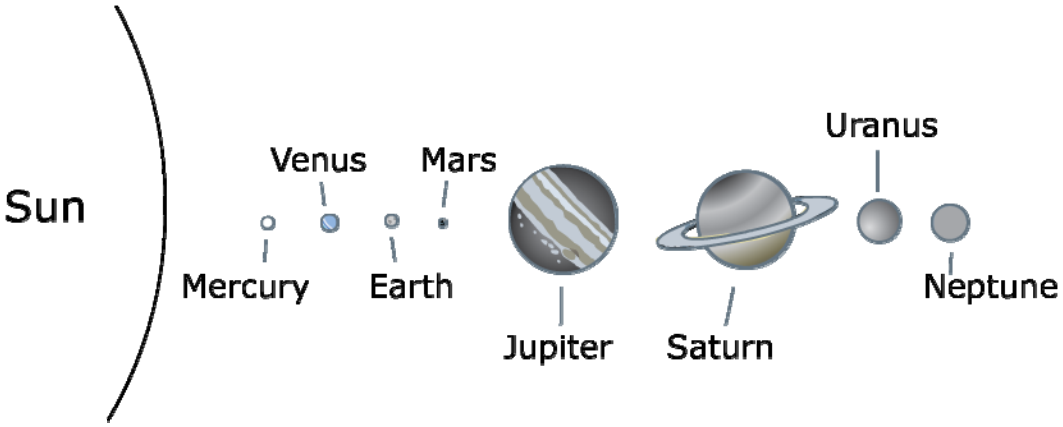
**C** If he is standing still, there are no forces acting on him.

**D** He wears a space helmet because the atmosphere is poisonous.

**E** Gravity depends on the air that is around.

**10.**

In diagrams of the solar system, the planets and their distances from the Sun are rarely shown to the same scale. The diagram below is one example.




Consider the following three statements:

**Statement 1:** The distances from the Sun to the planets are drawn with roughly the correct lengths relative to one another.

**Statement 2:** The distances from the Sun to the planets are drawn too small relative to the sizes of the planets and Sun.

**Statement 3:** The planets and Sun are drawn with roughly the correct sizes relative to one another.

Which of these statements do you agree with?

**A** 1 only

**B** 2 only

**C** 1 and 3 only

**D** 2 and 3 only

**11.**

Choose from the following responses for parts **a** and **b**, below.

**A** The Earth is spherical.

**B** The Earth rotates about its axis.

**C** The Moon revolves around the Earth.

**D** The Earth follows an elliptical orbit with the Sun at one focus.

**E** The Earth has an atmosphere.

**(a)** A large pendulum, several metres long and with a heavy metal bob, swings for several hours. The plane in which it swings appears to change, relative to the building, by about 15 degrees every hour.

Which one of **A** - **E** is most useful in constructing an explanation of this observation?

**(b)** Some stars, seen from the earth, appear to move in circles about the pole star.

Which one of **A** - **E** is most useful in constructing an explanation of this observation?

**12.**

A mug and a bathtub are filled with cool water. Each is heated by the same amount using similar immersion heaters switched on for the same time.

Which of the following is likely to be the best description of the water?

| | **mug** | **bathtub** |
|---|---|---|
| **A** | hot | cool |
| **B** | cool | hot |
| **C** | warm | warm |
| **D** | hot | hot |

**13.**

A photographer is in a photographic darkroom.
She switches on a battery-powered torch in order to find something.
She keeps the torch on for 60 seconds and then switches it off again.

**(a)** Which **one** of the following has less energy at the end of this 60 s interval than it had at the beginning?

**A** The torch battery

**B** The wires inside the torch between the battery and the bulb

**C** The walls of the darkroom and other objects in it

**D** The torch bulb

**E** None of them – energy is always conserved

**(b)** Which **one** of the following has had the biggest **increase** in its energy at the end of this 60 s interval?

**A** The torch battery

**B** The wires inside the torch between the battery and the bulb

**C** The walls of the darkroom and other objects in it

**D** The torch bulb

**E** None of them – energy is always conserved

**14.**

A car has been travelling for some time along a level road at a steady speed. At one instant it passes point A. Ten seconds later it passes point B, still travelling at the same speed.


Which of the following best summarises the energy transfer during the time interval between the moment the car passes A and the moment it passes B?

A chemical energy (petrol + air) → kinetic energy (car) + thermal energy (parts of car and surroundings) + sound

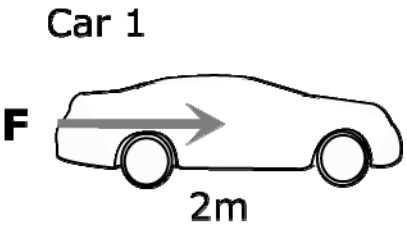
B chemical energy (petrol + air) → thermal energy (parts of car and surroundings)

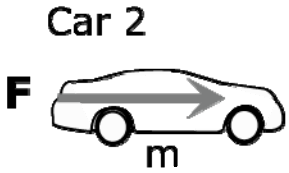
C kinetic energy (car) → thermal energy (parts of car and surroundings) + sound

D chemical energy (petrol + air) → kinetic energy (car) → thermal energy (parts of car and surroundings) + sound

**15.**

Two cars are being pushed from rest, with the same force F. Car 1 has twice the mass of Car 2.




In order to give both cars the same amount of kinetic energy, we should push:

**A** Both of them for the same distance

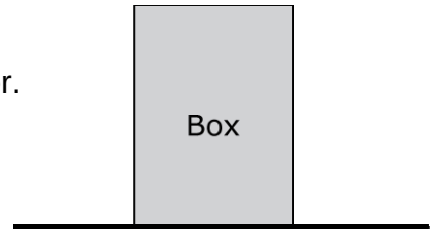
**B** Car 1 for twice as long a distance

**C** Both of them for the same time

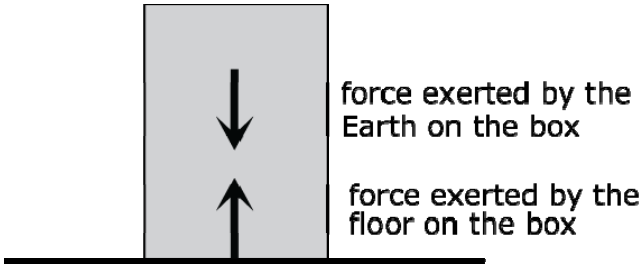
**D** Car 1 for twice as long a time

**16.**

A box is sitting on the floor.




**(a)** Two of the forces acting in this situation are shown in the diagram below.



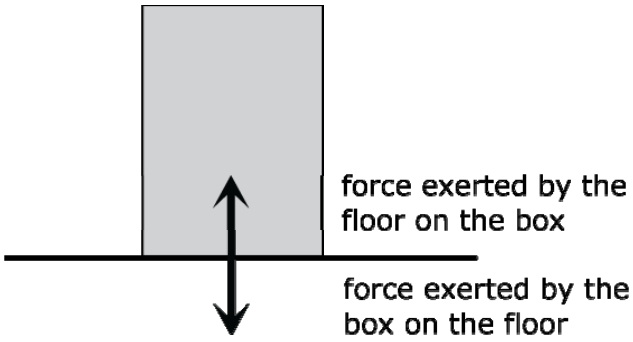

The two forces are the same size. What is the best explanation for this?

**A** Action and reaction are always equal and opposite.

**B** The box is not moving, so the forces on it must be balanced.

**C** Both of the above.

**(b)** This diagram shows another pair of forces in the same situation.




These two forces are the same size. What is the best explanation for this?

**A** Action and reaction are always equal and opposite.

**B** The box is not moving, so the forces on it must be balanced.

**C** Both of the above.

**17.**

A shopper pushes a trolley across a level floor.

She pushes with a force of 40 N. The trolley moves slowly, at a constant speed.


What is the size of the friction force on the trolley?

**A** more than 40 N

**B** exactly 40 N

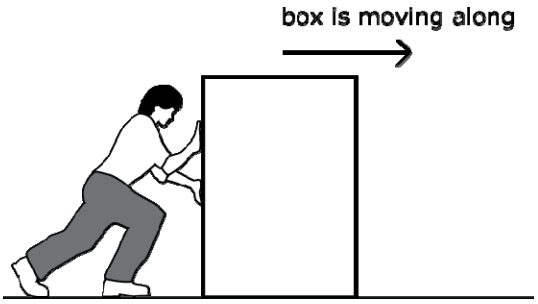
**C** a little bit less than 40 N

**D** a lot less than 40 N

**18.**

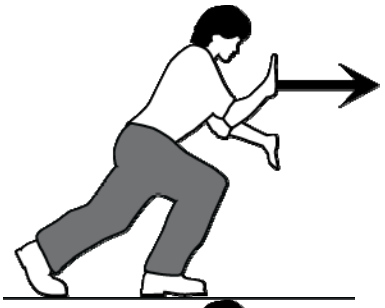
Pat is pushing a large box.

The box is **moving along at a steady speed.**

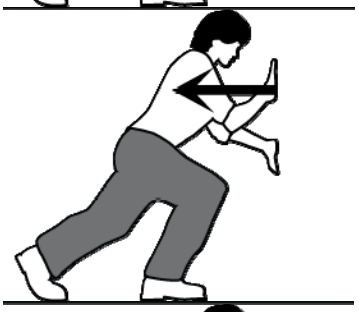



Which of the diagrams below best shows the **forces acting horizontally on Pat?** (Ignore any forces acting vertically.)

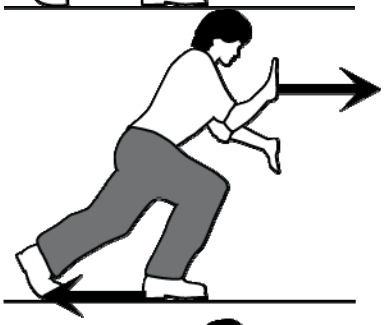
**A** The only force on Pat is a forward push of the box on his hands.



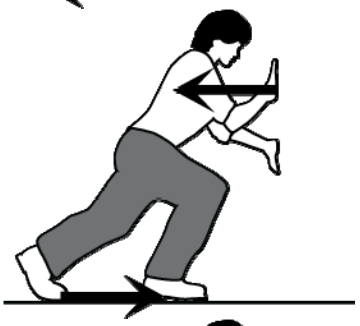
**B** The only force on Pat is a backward push of the box on his hands.



**C** There is a forward push of the box on his hands and a backward push of the ground on his feet.



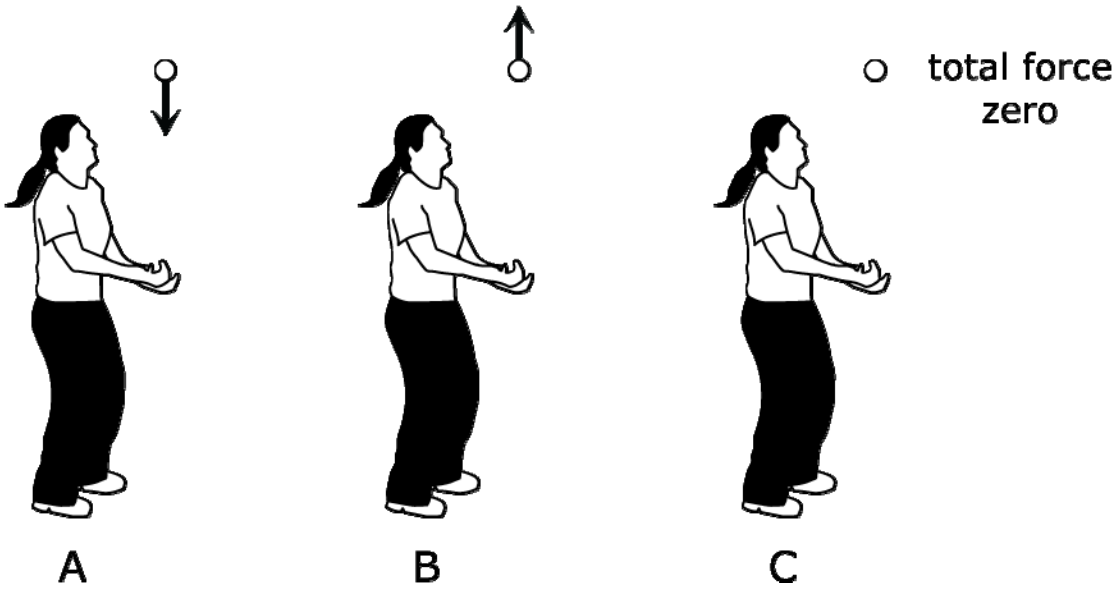
**D** There is a backward push of the box on his hands and a forward push of the ground on his feet.



**E** Pat and the box are moving along steadily, so there are no forces acting on Pat.

**19.**

Jan throws a tennis ball straight up into the air for a short distance and catches it when it comes down again.



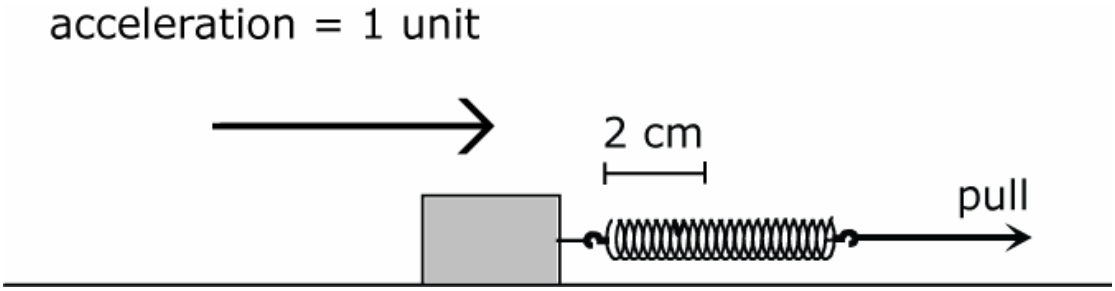

**(a)** Which diagram shows the total **force** acting on the ball **on its way up**?

**(b)** Which diagram shows the total **force** acting on the ball **right at the top of its flight**?

**(c)** Which diagram shows the total **force** acting on the ball **on its way down**?

**20.**

An astronaut tries out an experiment on Earth before setting off on a mission.
He uses a spring to pull a block along a smooth level surface. The friction force is so small that it can be ignored.
As he pulls, he keeps the spring stretched by exactly 2 centimetres all the time.
The block has an acceleration of 1 unit.




**(a)** He then repeats this experiment in his spacecraft while it is in Earth orbit. and everything is 'weightless'.

As before, he keeps the spring stretched by exactly 2 centimetres all the time. What will the acceleration of the block be now?

**A** More than 1 unit

**B** Exactly 1 unit again

**C** Less than 1 unit

**(b)** How would you explain this?

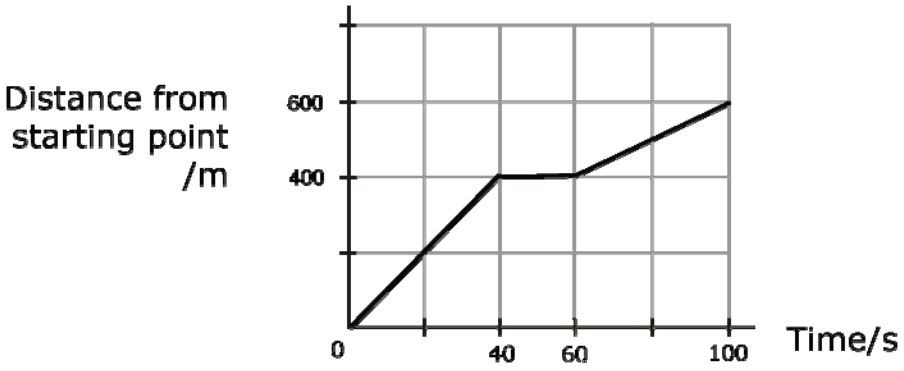
**A** In the spacecraft, the box is weightless, so it will move very easily.

**B** The mass of an object is constant, so the same force causes the same acceleration.

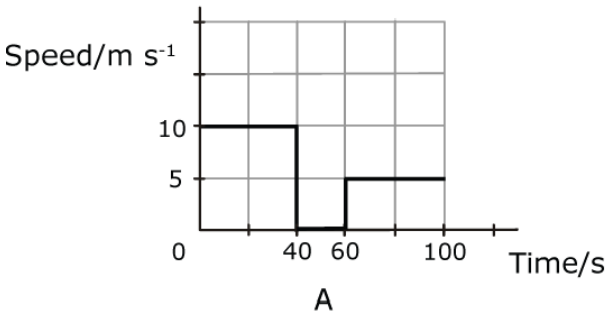
**C** Weight is a force, so in weightless conditions the force will have much less effect.

**21.**

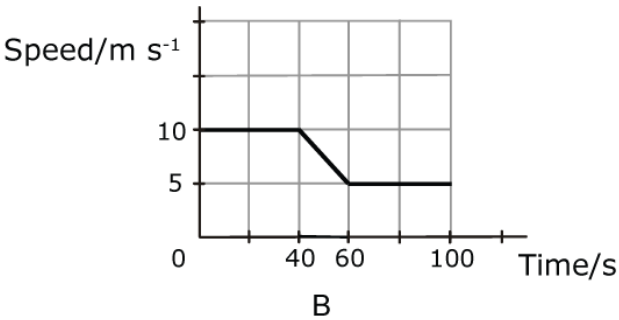
A car is travelling along a straight road. The graph below shows its distance from its starting point, over a period of 100 s.



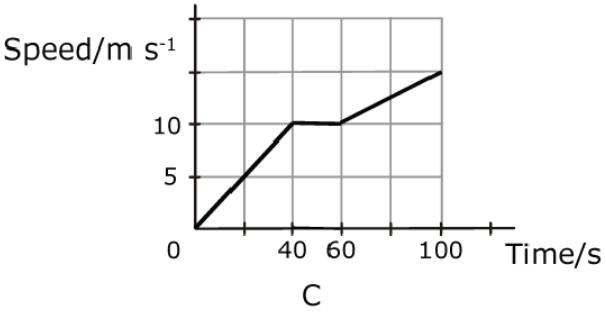

Which of the following graphs correctly shows the speed of the car during this journey?



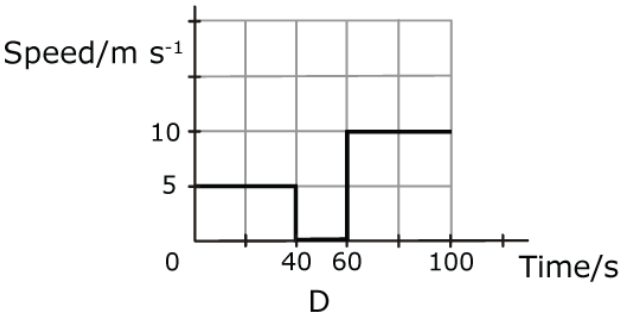

A




B




C




D

**22.**

**(a)** The relationship

$c = f\lambda$

can be rearranged. Which rearrangement is correct?

**A** $\lambda = f/c$

**B** $\lambda = cf$

**C** $\lambda = c/f$

**D** $\lambda = c - f$

**(b)** The relationship

$v = u + at$

can be rearranged. Which rearrangement is **not** correct?

**A** $u = v - at$

**B** $v - u = at$

**C** $t = a(v - u)$

**D** $\frac{v - u}{a} = t$

**23.**

The moment of a force is a measure of its tendency to rotate an object about some point. It is calculated by multiplying the force times its perpendicular distance from the point.

Which of the following can **not** be used as a unit for expressing a moment of a force?

**A** watt

**B** centimetre newton

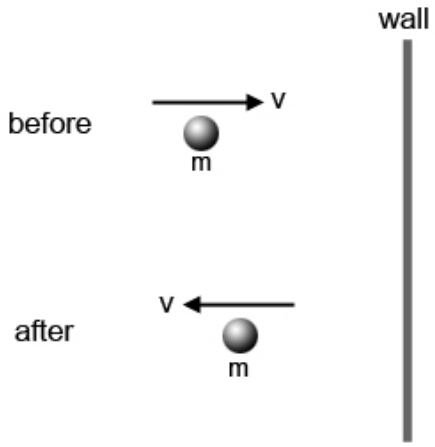
**C** metre newton

**D** newton metre

**E** millinewton metre

**24.**

When a molecule, mass m, speed v, hits a wall at right angles to the wall, and rebounds with the same speed v, the change of momentum of the molecule is 2mv. The factor two appears here because:




**A** The momentum of the molecule has changed from +mv to -mv.

**B** The change of momentum of the wall is zero.

**C** The momentum has no direction.

**D** The change of kinetic energy is $2(^1/_2 mv^2)$.

**E** For every molecule travelling towards the wall there will be a second travelling away from the wall.

**25.**

Consider how the following quantities vary:

**Quantity 1:** The gravitational field strength with distance from the centre of Earth, above the Earth's surface.

**Quantity 2:** The activity of a radioactive source with time.

**Quantity 3:** The intensity of light with distance from a star.

Which quantity varies (or vary) exponentially?

**A** 1 only

**B** 2 only

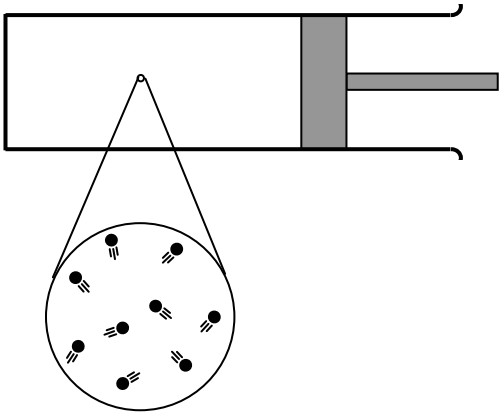
**C** 1 and 3 only

**D** 2 and 3 only

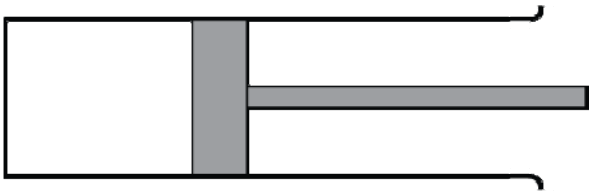
**E** 1, 2 and 3

**26.**

The diagram below represents the particles in a sample of gas inside a syringe.

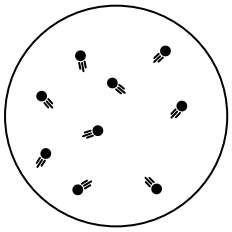


**(a)** The plunger is pushed in, so that the gas is squeezed into a smaller volume without changing its temperature.



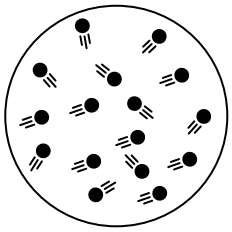
Which of the diagrams below best represents the particles now?

**A**



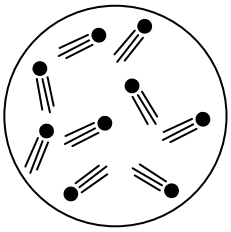
particles are smaller

**B**



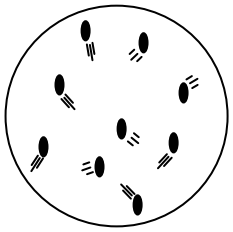
particles are closer together

**C**



particles are moving faster

**D**



particles are squeezed into a different shape

**(b)** Why does the pressure of a gas increase when it is compressed?

**A** The particles move faster.

**B** The particles hit each other more often.

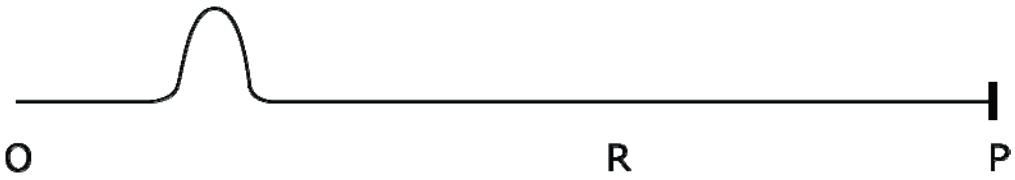
**C** The particles hit the inside surfaces of the syringe harder.

**D** The particles hit each part of the inside surface of the syringe more often.

**E** The air between the particles has been squeezed into a smaller space.

**27.**

A student is experimenting with pulses along a stretched elastic string. The string is tied to a fixed point P. There is a mark on the string at R. The student can send pulses along the string by moving end O up and down.




He observes a pulse travelling along the string, and times how long it takes to get to R. He now wants to make a pulse travel to R in a shorter time – by **changing just one thing** in the set-up. He considers each of the following possible changes:

**Change 1:** Increasing the tension in the string (making it tighter)

**Change 2:** Moving his hand up and down further, making a bigger pulse.

**Change 3:** Moving his hand up and down faster, making a sharper pulse.

Which of these changes, on its own, would make a pulse travel to R in a shorter time?

**A** 1 only
**B** 2 only
**C** 2 or 3 only
**D** 1, 2 or 3

**28.**

Here are some wave phenomena:

**A** Refraction
**B** Reflection
**C** Diffraction
**D** Interference
**E** Dispersion

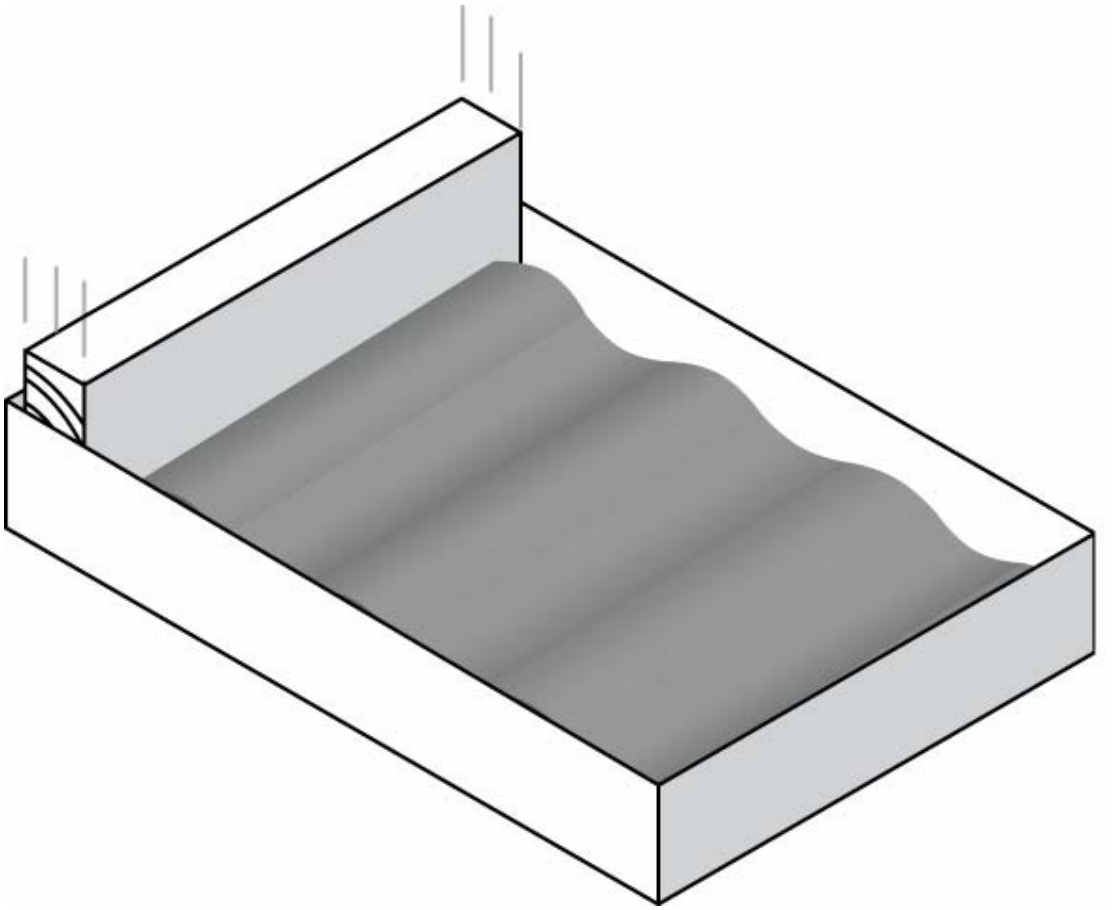
For each of **a** and **b**, which term best describes the process involved?

**a)** A sound made near the wall of a building is heard around the corner.

**b)** A converging lens brings a parallel beam of light to a focus.

**29.**

A teacher uses a straight horizontal piece of wood to make wave pulses at one end of a long tank of water.



Each pulse of waves gets fainter as it goes, and eventually cannot be seen any more. Which of the following **best** explains why this is so?

**A** As the waves move forwards, friction effects make the wave-speed get less.

**B** As the waves move forwards, friction effects make the amplitude get less.

**C** As the waves move forwards, friction effects make the frequency get less.

**D** Water waves are not affected by friction, but just fade out as they lose energy.

**30.**

A person in a photographic dark-room switches on an electric light. The light-bulb is the only source of light in the room.

Which of the following is the most complete and correct explanation of how the person is able to see an object in the room?

**A** The light bulb bathes the room in light. This makes it possible to see an object anywhere within the room.

**B** The bulb emits light, which travels outwards in all directions. Some of it hits the object and illuminates it. When a person directs their gaze towards the object, they are able to see it.

**C** The bulb emits light which travels outwards in all directions. Some of it hits the object. This makes it bright enough for a person to see it.

**D** The bulb emits light which travels outwards in all directions. Some of it hits the object. Light is then reflected from every point of the object, again going in all directions. Some of this enters the person's eye.